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DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review

1.1.1.5 Changes of price elasticity of select waste feedstock with increased demand

3/11/2021

Feedstock Technologies

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ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

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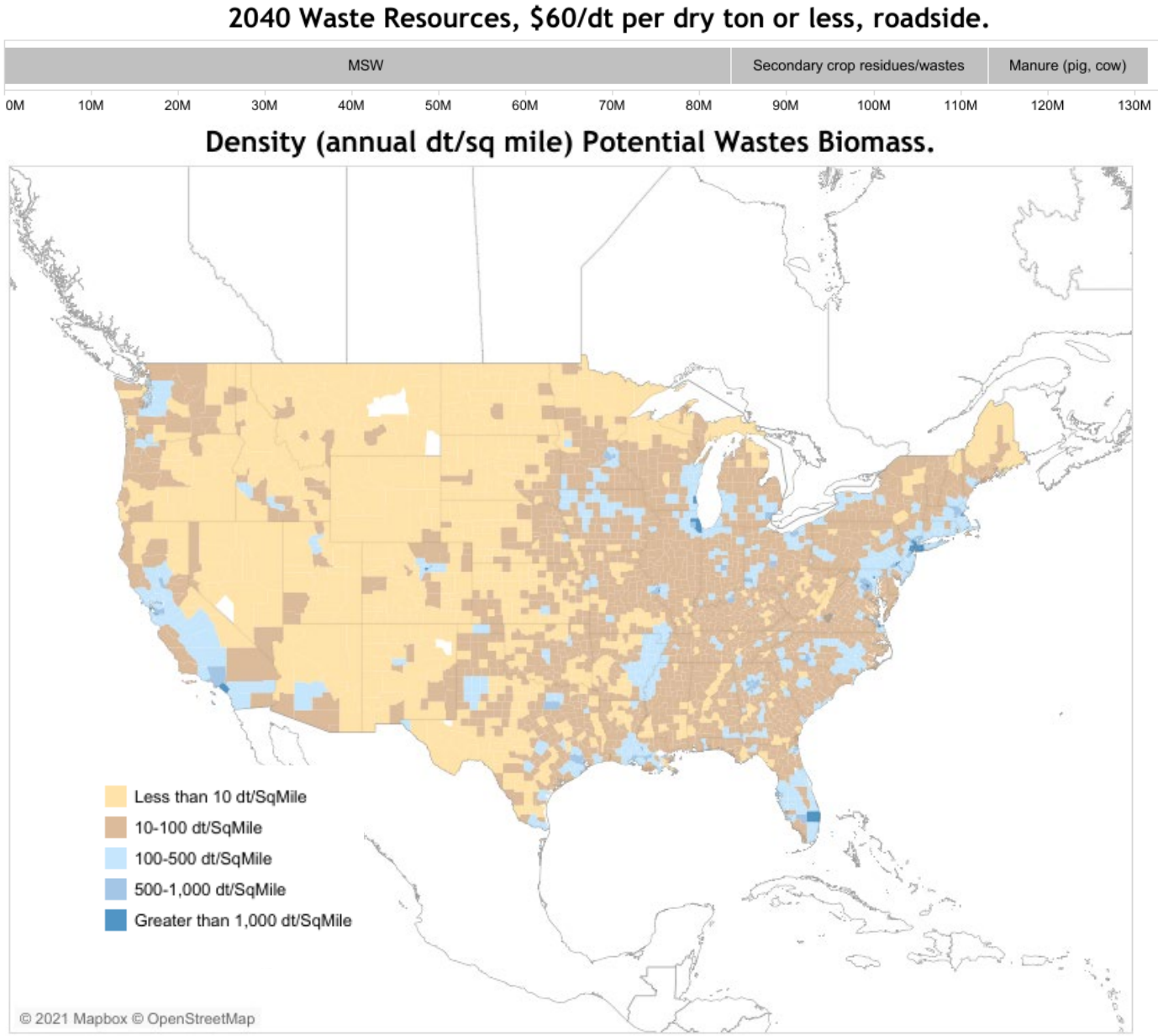
Project Overview

- *~100 million tons per year of biomass waste biomass resources, e.g. municipal solid waste (MSW) in the U.S.*
- *Low or negative cost, but cost relationship with demand is unknown.*



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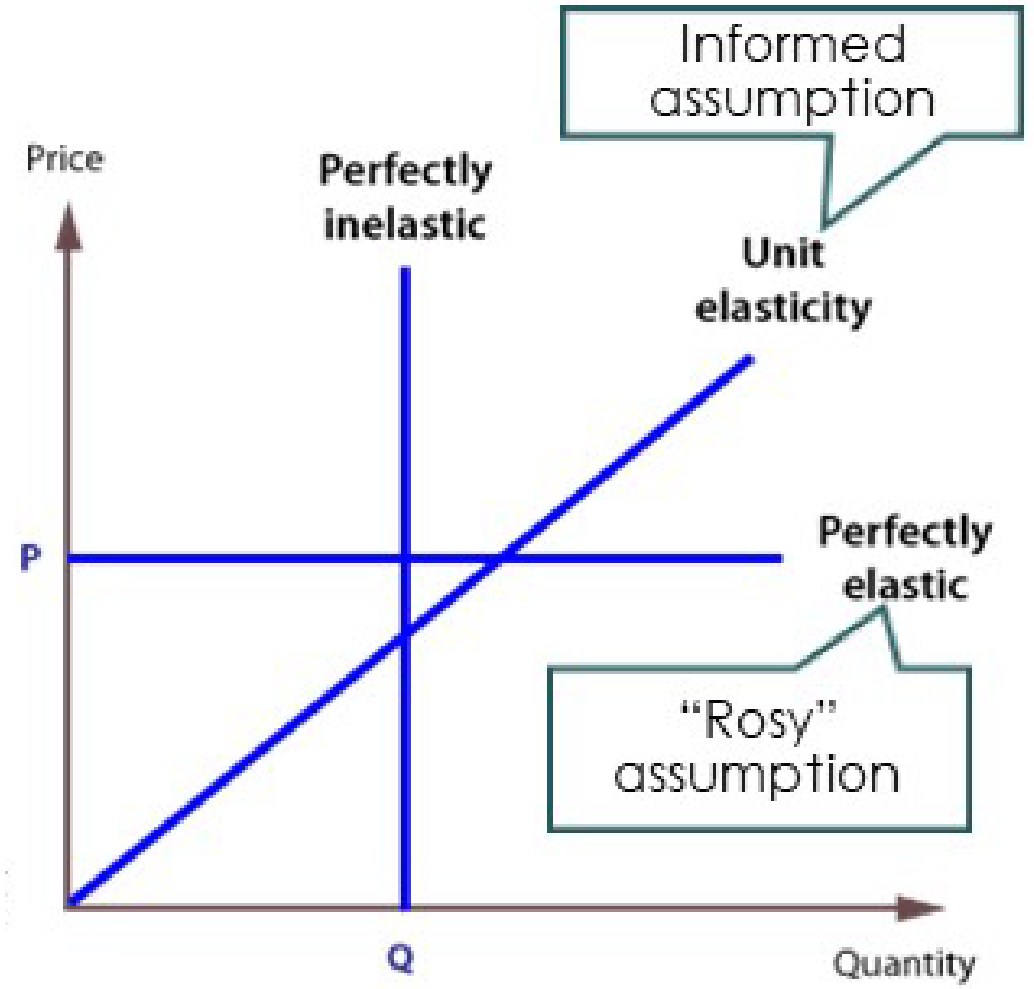
Project Overview

- *Goal is to quantify price elasticity of supply (PES) of biomass waste resources.*
  - *Quantify change in price with change in demand.*
  - *"…the amount of feedstock available at negative prices will decrease as demand for them increases." (Badget et al 2019)*
  - *Important to understand "cost advantage" of wastes.*
  - *Risk in erroneous feedstock cost assumptions.*



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1 – Management

- Work plan is developed and coordinated with DOE.
- Project management: Matthew Langholtz at ORNL.
- Data for waste resources in FY20: Anelia Milbrandt at NREL (dried distillers' grains, yellow grease, biosolids).
- Industry survey data in FY21: subcontract to BioResource Management, Inc.
  - Seven material recovery and recycling facilities (MRFSS) from 2015 to 2020.
  - Industry data of plastics recyclables from 2015 to 2020.
  - Waste wood and recyclables used at Evergreen Community Power Plant (ECPP), Reading Pennsylvania.
  - MSW used at the Covanta Tulsa Renewable Energy, Tulsa, Oklahoma.
- *Risk that market data are unavailable for waste resources.*
  - *Mitigation: Use case studies to quantify PES*

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2 – Approach

Approach: quantify price elasticity of supply (PES) based on change in price under supply or demand changes.

- Approach in FY20: Quantify PES based on proxy resources with price history (e.g. yellow grease).
- Challenge: price difficult to find for wastes.
- Approach in FY20: Case studies with observable supply shocks.
- Go/No-Go FY21: Successfully quantify PES for at least two waste scenarios.
- Criteria: Find sufficient data and adequate statistical relationship ($r^2>0.5$) to quantify PES.

3 – Impact

Feedstock Technology Platform increasing interest in waste resources

- Waste to energy is viewed as cost advantaged.
- Anectodical evidence that tipping fees may go away as demand increases.
- Understanding relationship between waste cost and waste demand needed to inform TEAs of waste-based processes.

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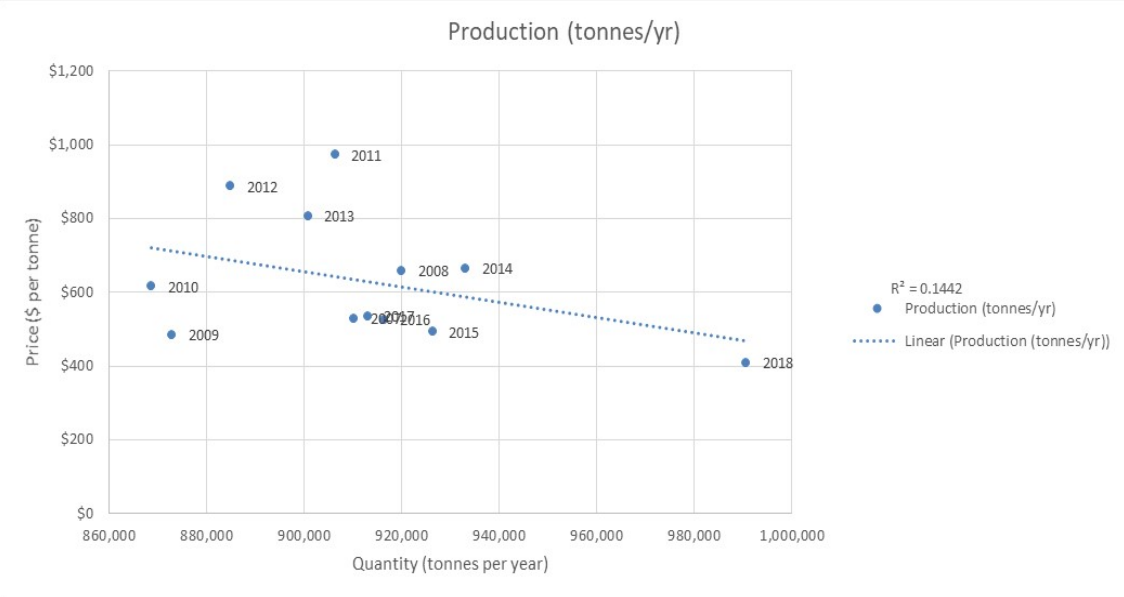
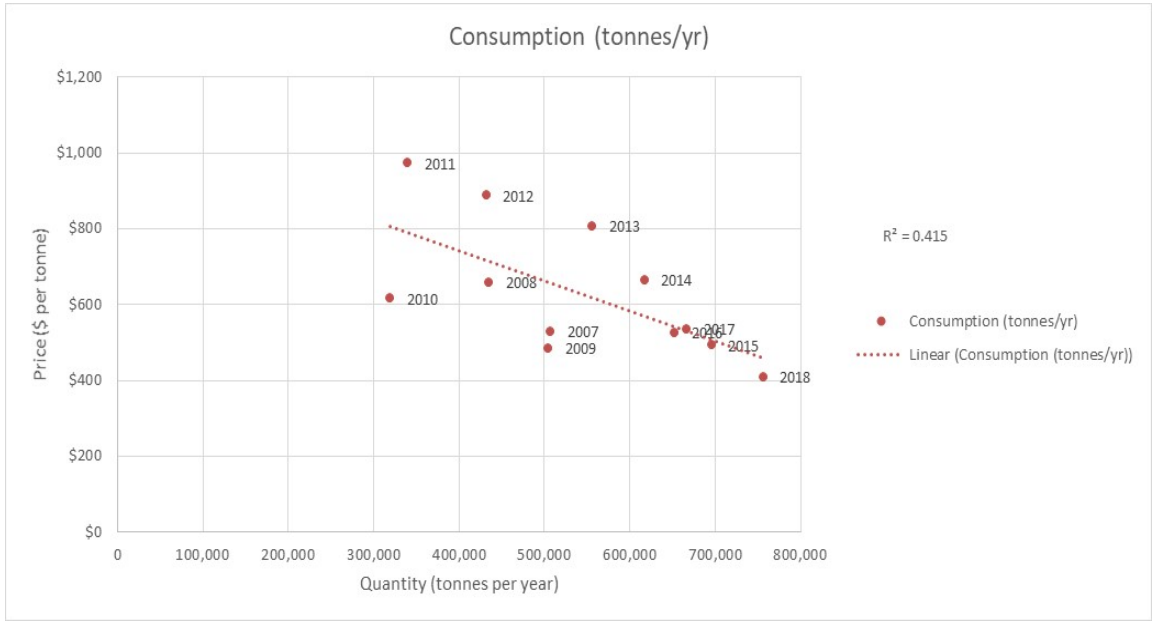
4 – Progress and Outcomes

Yellow grease market data (National Renders Association Market Report 2006, 2008, 2011, 2013, 2015, 2017, and 2019).



Historical data of price of yellow grease plotted against production(r^2=0.37).



Historical yellow grease price and consumption (r^2=0.42).

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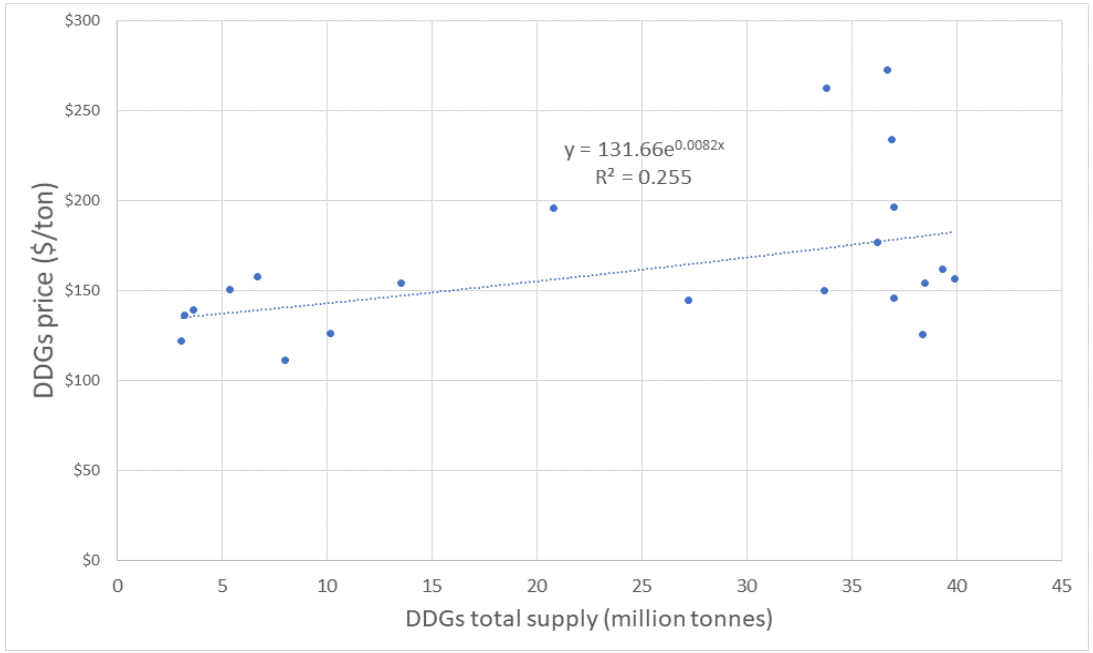
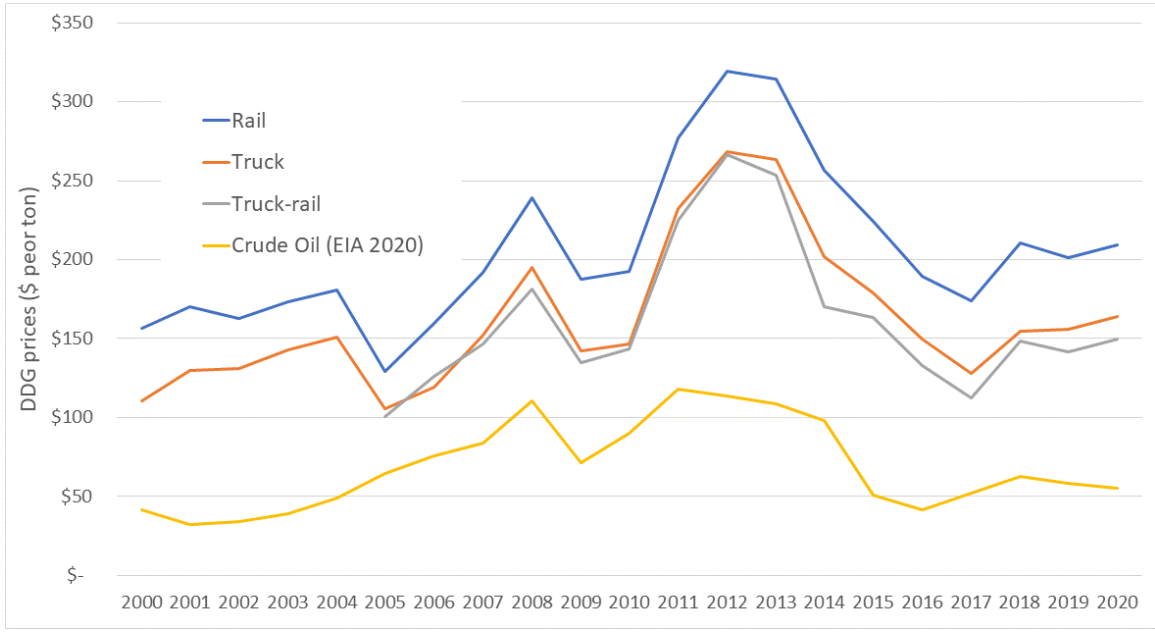
4 – Progress and Outcomes

Dried distillers' grains, USDA Agricultural Marketing Service 2020





Historical data of price of DDGs plotted against consumption (r^2=0.26).

Historical price data of DDGs and oil ($2018). Data sources: USDA AMS and IEA 2020.

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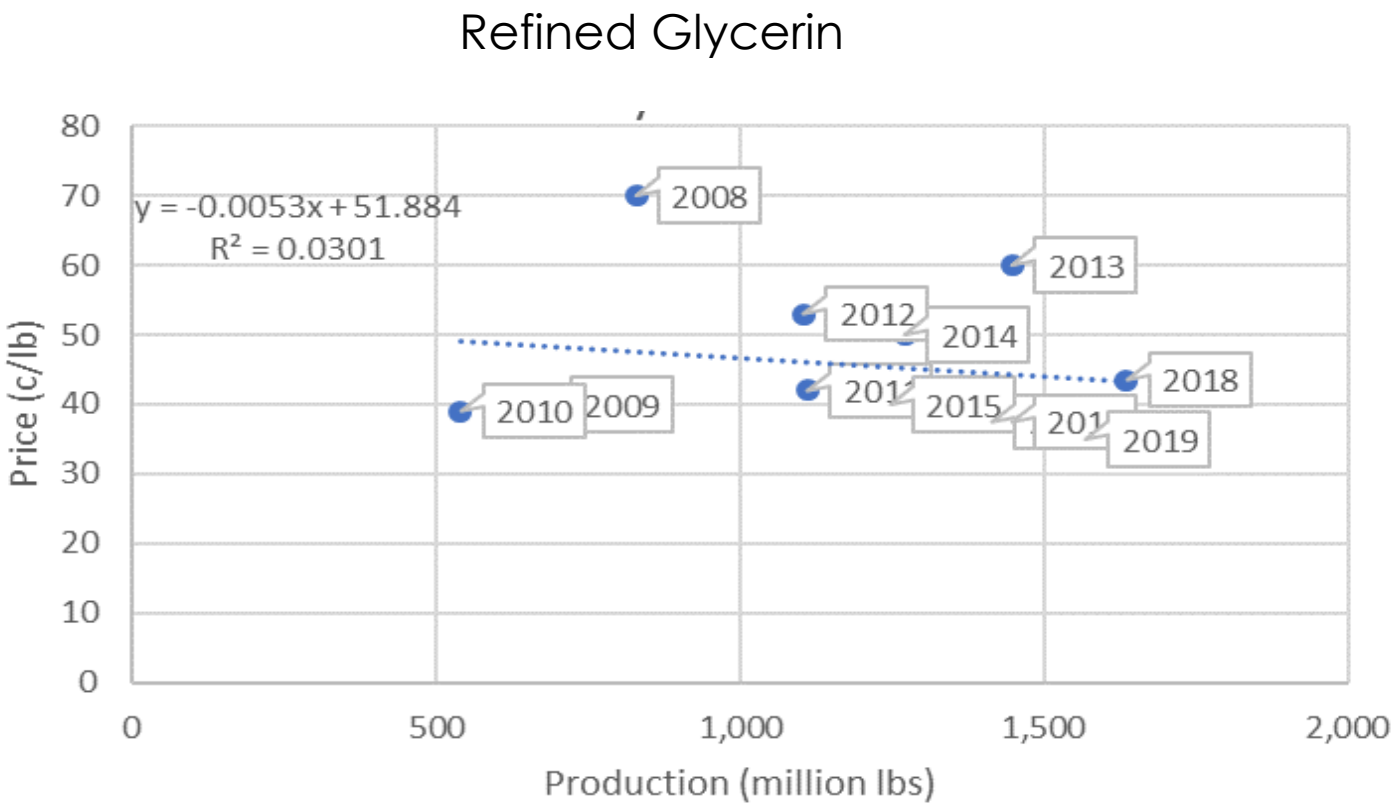
4 – Progress and Outcomes



Historical data of price of glycerol plotted against production. Correlation was not found to be statistically significant (r2=0.03). Data source: https://www.oleoline.com/products/Refined-Glycerine-Market-Report-5.html.

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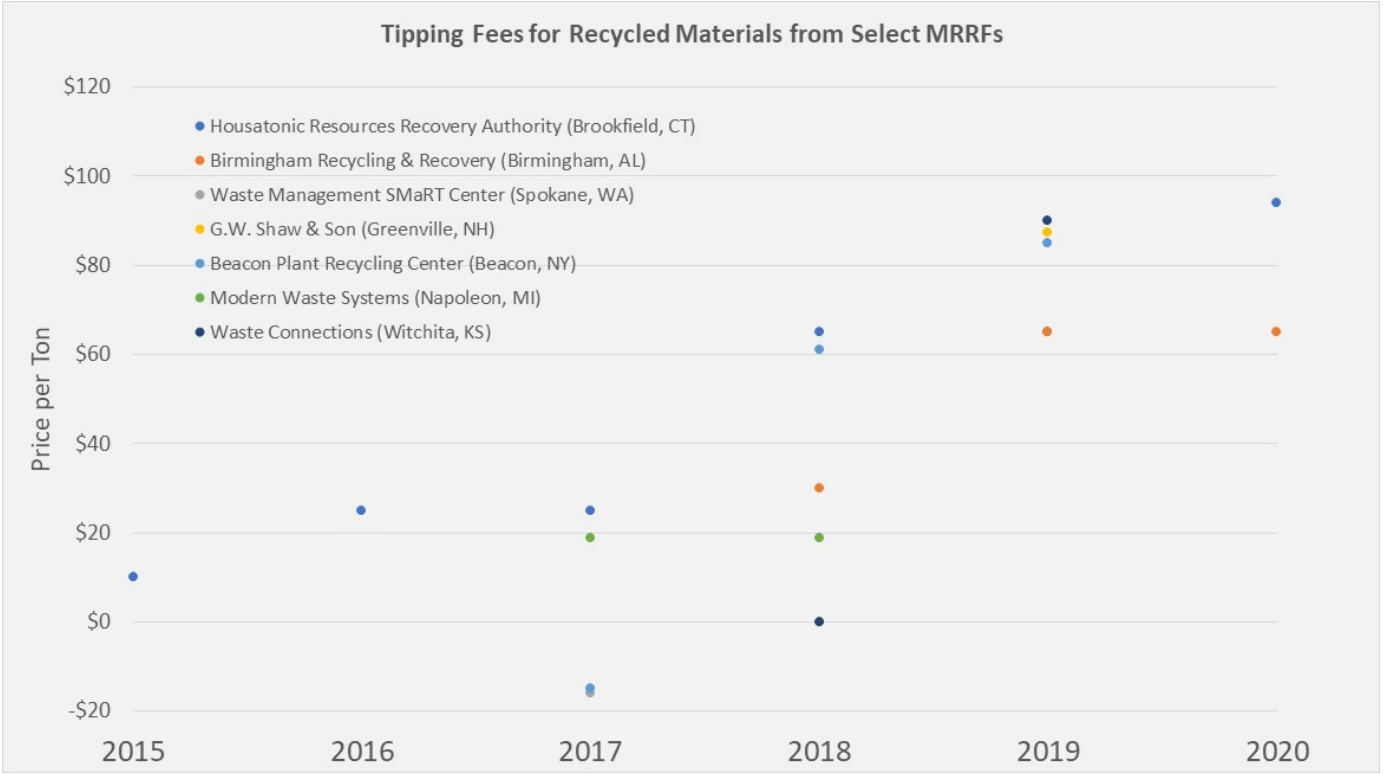
4 – Progress and Outcomes

Comingled recycleables:
China's Notification to the World Trade Organization Committee on Technical Barriers to Trade 17-3880, June 2017, stopped import of:

- 3915100000: Waste, Parings and Scrap of Polymers of Ethylene
- 3915200000: Waste, Parings and Scrap of Polymers of Styrene
- 3915300000: Waste, Parings and Scrap of Polymers of Vinyl Chloride
- 3915901000: Waste, Parings and Scrap of Polymers of Glycol Terephthalate
- 3915909000: Waste, Parings and Scrap of Plastics



Quantity of comingled recyclables used in China and associated procurement price by year, expressed as inverse of tipping fee, of select MRRFs in seven states. As exports decreased, procurement prices also decreased.

Year	Quantity from US to China (million tons)	CT	AL	WA	NH	NY	MI	KS
		Procurement price ($ per ton)						
2015	18.3	-$10						
2016	17.9	-$25						
2017	15.4	-$25		$16		$15	-$19	
2018	10.3	-$65	-$30	-$123	$0	-$61	-$19	$0
2019	6.8	-$65	-$65		-$88	-$85	-$133	-$90

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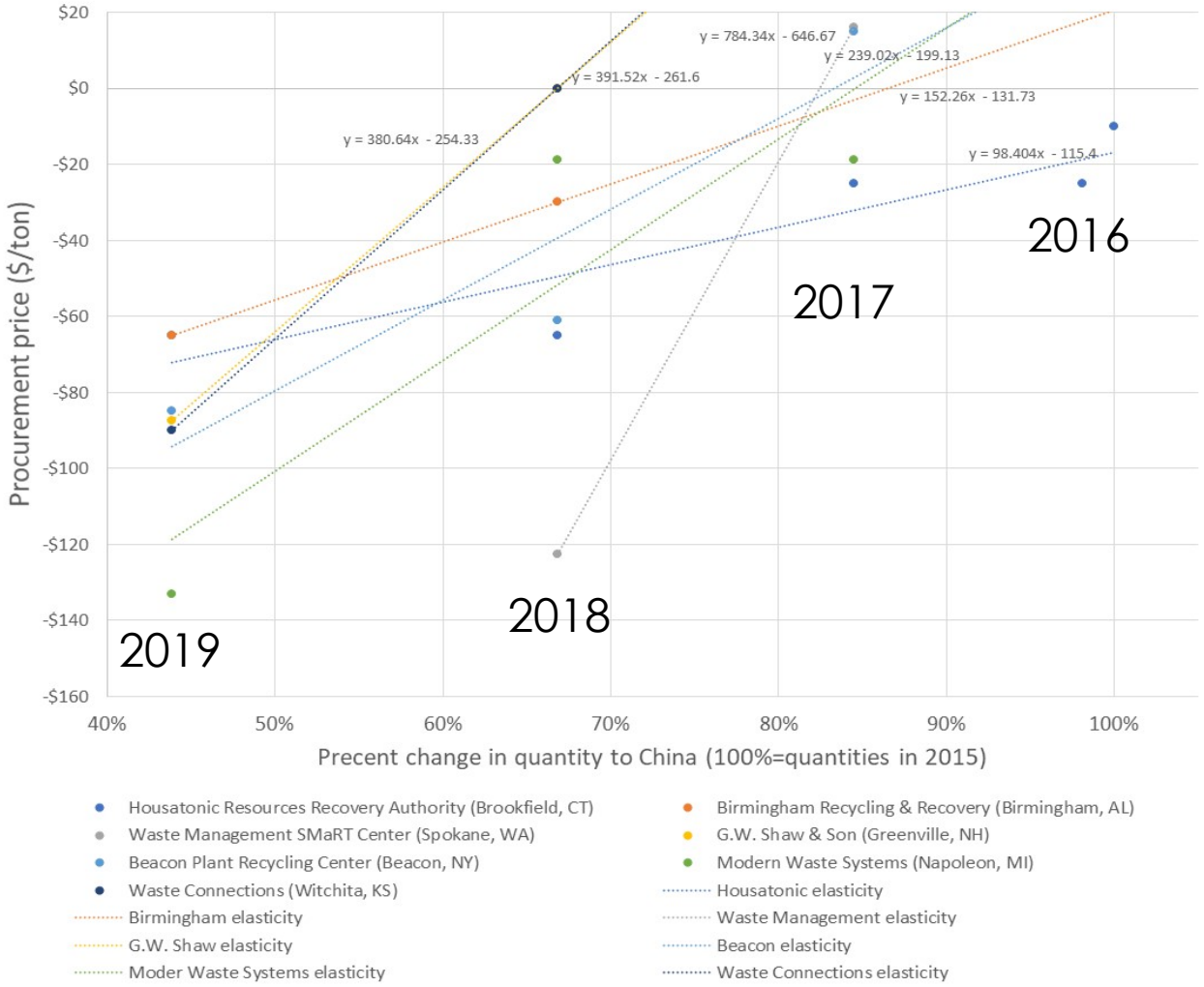
4 – Progress and Outcomes



Elasticities expressed as change in procurement price associated with change in quantity accepted:

Location	Elasticity (Δ price ($/ton) per Δ percent quantity used)
Housatonic Resources Recovery Authority (Brookfield, CT)	$0.98
Birmingham Recycling & Recovery (Birmingham, AL)	$1.52
Waste Management SMaRT Center (Spokane, WA)	$7.84
G.W. Shaw & Son (Greenville, NH)	$3.81
Beacon Plant Recycling Center (Beacon, NY)	$2.39
Modern Waste Systems (Napoleon, MI)	$2.92
Waste Connections (Wichita, KS)	$3.92
Average:	$3.34

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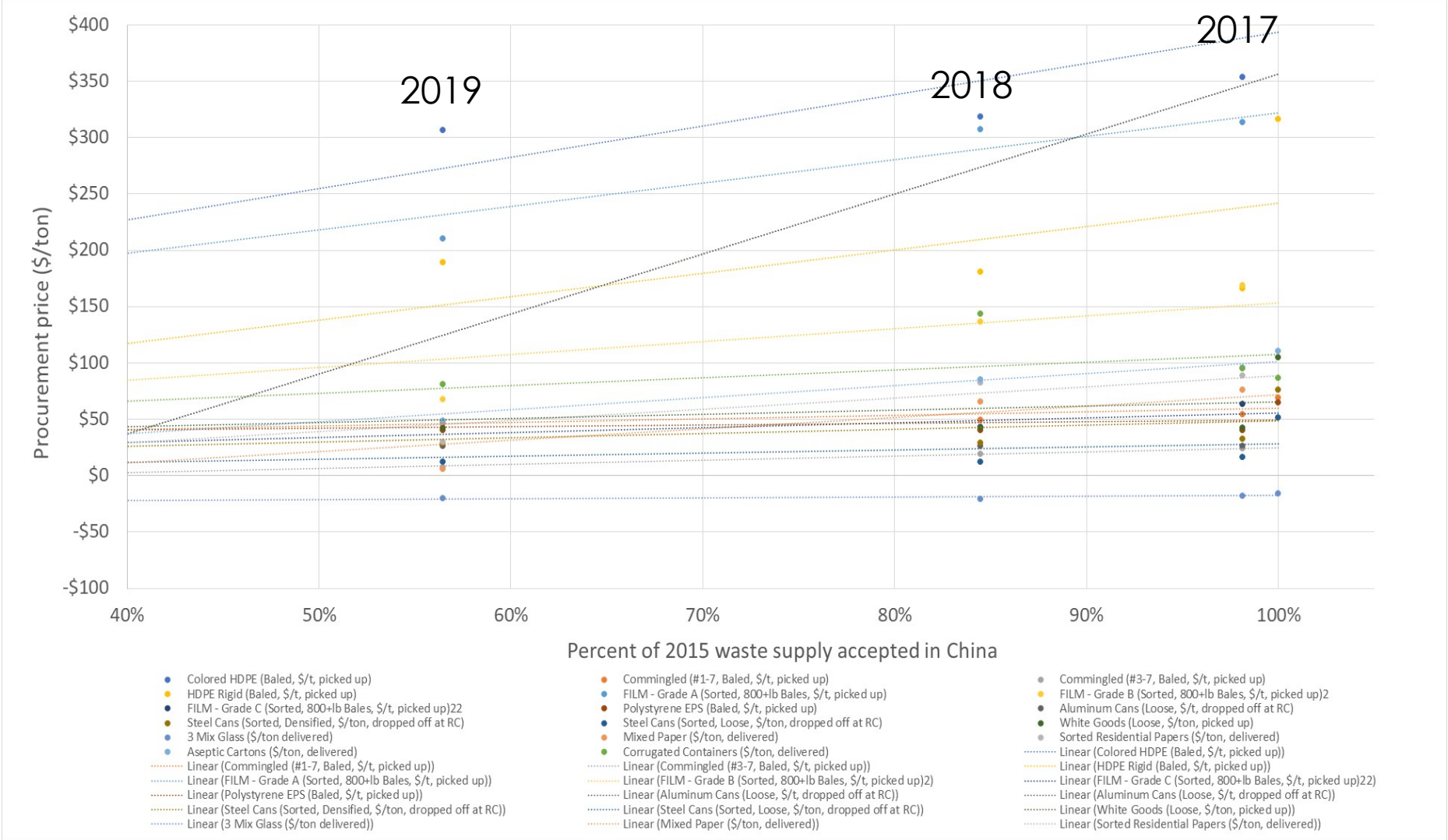
4 – Progress and Outcomes

Pre-sorted recyclables, seventeen categories from www.recyclingmarkets.net



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4 – Progress and Outcomes

Pre-sorted recyclables, seventeen categories from www.recyclingmarkets.net

R-square, PES ($/ton price increase per 1% demand increase), identification of plastics, and identification of an r-square value > 0.5.

Waste type	R^2	PES	Plastics?	R^2>.5?
Polystyrene EPS (Baled, $/t, picked up)	0.23	$ 0.14	Yes	
Colored HDPE (Baled, $/t, picked up)	0.84	$ 2.27	Yes	Yes
FILM - Grade A (Sorted, 800+lb Bales, $/t, picked up)	0.96	$ 2.08	Yes	Yes
HDPE Rigid (Baled, $/t, picked up)	0.65	$ 2.07	Yes	Yes
FILM - Grade B (Sorted, 800+lb Bales, $/t, picked up)	0.74	$ 1.14	Yes	Yes
Aseptic Cartons ($/ton, delivered)	0.96	$ 1.07	Yes	Yes
FILM - Grade C (Sorted, 800+lb Bales, $/t, picked up)	0.80	$ 0.43	Yes	Yes
Commingled (#3-7, Baled, $/t, picked up)	0.97	$ 0.37	Yes	Yes
Commingled (#1-7, Baled, $/t, picked up)	0.79	$ 0.32	Yes	Yes
Aluminum Cans (Loose, $/t, dropped off at RC)	0.25	$ 5.32		
Corrugated Containers ($/ton, delivered)	0.44	$ 0.70		
Steel Cans (Sorted, Densified, $/ton, dropped off at RC)	0.41	$ 0.38		
White Goods (Loose, $/ton, picked up)	0.25	$ 0.37		
Steel Cans (Sorted, Loose, $/ton, dropped off at RC)	0.34	$ 0.27		
Mixed Paper ($/ton, delivered)	0.82	$ 1.01		Yes
Sorted Residential Papers ($/ton, delivered)	0.87	$ 0.99		Yes
3 Mix Glass ($/ton delivered)	0.70	$ 0.08		Yes
Average PES		$ 1.12		

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Summary

- Assuming persistent negative costs for waste biomass may be overly optimistic.
- For a supply shock attributable to the China Green Fence Policy:
  - Local price increased of $2-$3 per percent change in demand.
  - Extensive price increased of about $1 per percent change in demand.
- Future work in FY21:
  - Waste wood and recyclables used at Evergreen Community Power Plant (ECPP), Reading Pennsylvania.
  - MSW used at the Covanta Tulsa Renewable Energy, Tulsa, Oklahoma.

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Quad Chart Overview

Timeline

- 10/1/2019
- 9/30/2021

	FY20	Active Project
DOE Funding	$150k	$300k

Project Partners*

- NREL
- Bioresource Management Inc.

Barriers addressed

Ft-A. Feedstock Availability and Cost

At-C. Data Availability across the Supply Chain

Project Goal

Quantify price elasticity of supply of waste resources to understand potential change in price as a function of change in demand.

End of Project Milestone

Recommend PES assumptions for negative-price feedstocks.

Funding Mechanism

?Specify lab call topic and year, if applicable.

*Only fill out if applicable.

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Additional Slides

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Responses to Previous Reviewers' Comments

- N/A, no previous review.

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Publications, Patents, Presentations, Awards, and Commercialization

- N/A, publication forthcoming in FY21.

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